

Problem Set 3 Solutions

Problem 1-1. Thermoforming

Consider the thermoformed part drawn in Figure 1 which was used to package last semester's hamburger yo-yo. This part was unapologetically difficult to manufacture, and this problem will investigate some of its pitfalls.

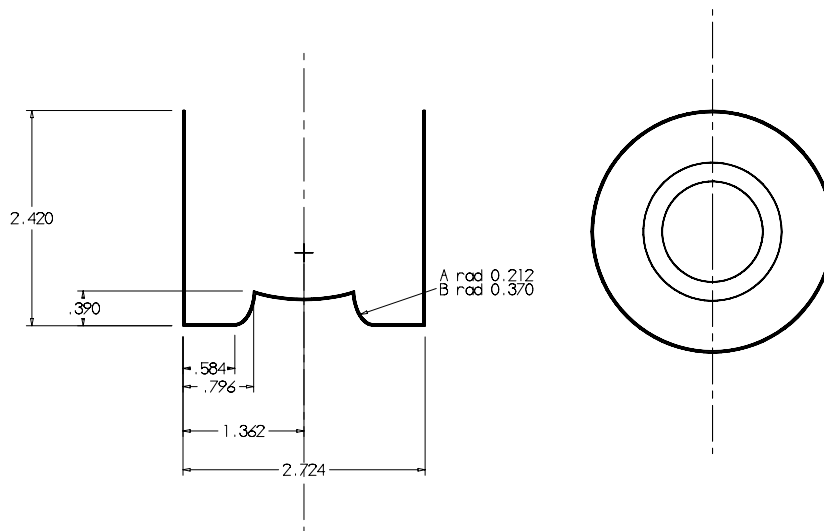


Figure 1: Thermoformed part

(a) Compute the part's draw ratio. Is it reasonable?

The draw ratio is the depth over the width = $\frac{2.420}{2.724} = 0.888$ which is perfectly reasonable.

(b) The part was formed from a sheet of clear polystyrene with thickness 0.030 inches and dimensions 4 inches by 4 inches square. The part was vacuum-drawn with a clamp that enclosed an area of approximately 3.5" by 3.5". Assuming that the drawn part has uniform thickness, what is the wall thickness.

First we need to approximate the surface area of the inside of the part. Kudos go to Brian Ruddy who generated a solidworks model that does all the hard work. His model reports an area of $A = 27.57 \text{ inches}^2$. The material that is drawn depends on the geometry of the mold. If you are optimistic and assume all of the material from the 3.5 inches² clamped area gets drawn, then the part thickness would be

$$(0.030) \frac{3.5^2}{27.57} = 0.013 \text{ in}$$

In reality, as soon as the lip of the warm plastic touches the sides of the mold no more of that external area gets drawn into the mold. Therefore, a more realistic calculation is to assume that drawing area is approximately 120 percent of the diameters of the part.

